Internet Virtual Community - A Platform for Learning Online

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Abstract

Distance Learning is a tendency by the development of Internet. This paper introduces an integrated distance learning system, *Internet Virtual Classroom* (*IVC*). It is a community-based learning system developing both *Community Tools* and *Personal Tools*. In learning community, IVC also designs a cooperative environment, the *Virtual Experiment Environment* (*V.E.E.*), for learners operate experiment together on the web. The assisted application inside the *V.E.E.* is *Intelligent Agent*, which have a special knowledge structure, *Knowledge Map*, in its mind in order to lead them provide suggestions and solve problem for learners. To make *Knowledge Map* have more utilization, a problem solving system is constructed to follow four steps of problem solving strategies. The further usage of *Knowledge Map* is misconception diagnosis. An *iTest System* is composed by using two matrices to calculating student's concept distribution and find her/his misconception. Using these equipments and techniques, both teacher and student can get enough information and have convenient tools in a platform for learning online.

Keywords: IVC, *V.E.E.*, Problem Solving, Knowledge Map, Data Mining, Misconception Diagnosis

1. Introduction

Recently, distance education via Internet is surely the prior consideration when the teacher and students are separated. Various computer-assisted learning methods are implemented for accomplishing those learning activities in the environment of traditional education. As the result, users from diverse places can choose different learning styles to confirm their own requirements. [7] One of the advantages of distance education systems is that it allows the users to perform learning activities such as reading, discussion, and examination via network regardless of time and space.

The purpose of this paper is discussing an integrated distance learning environment called *Internet Virtual Classroom* (*IVC*) and its related researches. Section 2 describes some common CAI Systems. *IVC* and its *Virtual Experiment Environment* (*V.E.E.*) are discussed in Section 3. Section 4 talks about designed *Intelligent Agent* and its knowledge structure, *Knowledge Map*. By using the *Knowledge Map*, an *On-Line Test System - iTest System* is developed in Section 5. Section 6 gives a brief conclusion and some future works.

2. CAI Systems

As the invention of computer, there are revolutions occurred in many fields including education. In the instructional area, some interactive programs, called CAI Systems (Computer-Assisted Instruction Systems), are developed for help students learning. [12] Teachers could use CAI Systems as intermediary media to teach students in different ways via multi-media, network *etc.*. Moreover, students can also use CAI Systems to get knowledge through the interactive learning environment or other attractive media. In CAI Systems, some researches focused on the *Problem Solving*. These researches include how to transform a regular problem into computer, [23] how to build a problem solving environment *etc.* [2][3] Some CAI Systems also concentrate on the applications of Intelligent Agent. Several distance learning systems propose agents for managing system files [28], notifying grades in on-line quiz system [25] and so on.

Since the middle 1980's, a special meaning, which indicating a group of people with same interests and exchange opinions though network, of word has appeared; it is called "virtual community". According to the definition of virtual community proposed by Howard Rheingold (1993), a virtual community is a societal aggregation which formed when there are enough people discussing with each other for developing relationship through network. [26] Moreover, Romm also believes that virtual communities are a relatively new phenomenon and are groups of people who communicate with each other via electronic media. [27] In this paper, the integration of traditional CAI System and virtual community will be taken into our considerations as we design the online learning platform, *IVC*.

3. IVC and VEE

Internet Virtual Community (*IVC*) is a web-based virtual community environment, which supports both *Community Tools* and *Personal Tools* as shown in Figure 1. [32] *Community Tools* are used for giving related information and communication facilities among the members of community. *Community Tools* are composed of three major tool categories, *Community Information Tools*, *Synchronous Communicating Tools*, and *Asynchronous Communicating Tools*. In *Community Information Tools*, most related community information can be viewed such as the member list, news of community, and community homepages. People can use the information to realize the spirit of the community. *Synchronous Communicating Tools* offer community member to *talk* to each others at the same time, such as "chatroom" in IVC. The last category of *Community Tools* is *Asynchronous Communicating Tools*, which make community members have a convenient information-interchange environment. "Site recommendation", "file sharing", and "discussion area" are three major *Asynchronous Communicating Tools* supported in IVC.

In *Personal Tools*, there are also three major categories include *Information Storages Tools*, *Preference Settings*, and *Personal Equipments*. *Information Storages Tools* give users space to store personal information and data. User can also use *Preference Settings* to set her/his favorite communities or list her/his friends in different communities. The most significant *Personal Tools* in IVC are *Personal Equipments*, which support special apparatus for users. One of them is *Agent House*, a special environment for user depositing different agents. The detail of agents will be introduced in the next Section. Besides those essential tools in common communities, the architecture of IVC also focuses on a special community called *learning community*.

Figure 1: snap of *IVC*

To assist the users with learning, *learning communities* in IVC has three additional functions: *Instruction Area*, *On-line Quiz*, and *Grades Notification Area*. The *On-line Quiz* is an assessment area for teacher to judge the learning status/results of students and their grades will be published in *Grades Notification Area*. The further research of the *On-line Quiz* will be discussed in Section 5. In the *Instruction Area*, a learning flow control mechanism is necessary for maintaining the learning schedule during the learning process. A previous research about flow control mechanism in *IVC* used the idea of Petri-net to manage the whole instructional process.[20] Besides the flow control mechanism, *IVC* also supports an on-line experiment area for students operating virtual experiment alone/together. It is called Virtual Experiment Environment (or *V.E.E.* for short).

In a traditional experiment class, students usually can operate the experiment equipment by hand and observe the variation of experiment directly. After finishing the experiment, they can discuss the result and record the data with each other. [17] *V.E.E.* tries to make students have the same experience in the traditional experiment class and follows two major Educational Technologies: Seven Stages of Problem Solving cycle [1] and Science Process Skills. [8] *V.E.E.* also makes a simulated platform which provides learners experiment with virtual equipment on computers in previous work. [11][13] There are two techniques used in *V.E.E.*. One is *Virtual Lab*, which use interactive simulation for students to operate. The other is *Visual Lab*, which use video to display the process of experiment and support tools for students to measure data. [17]

Visual Lab uses video-media which can record and save the operating procedure in digital animation file to show the reality of experiment. Some simulation toolboxes are provided to let students observe it repeatedly. Accordingly, students may have real feeling and make sense just as they do in actual experiment environment. In Visual Lab, teachers can produce some experiment video and put them on the Web so students can observe, measure, and record such experiment using some tools. In additional to the basic experiment equipments in *V.E.E.*, an effective assistant tool makes students have more convenience when operating the experiment; that is the intelligent agent.

4. Intelligent Agent

Sometimes, when students are operating an experiment, they might have some uncertainty of processes or misusing of methods. In a traditional lab, there'll be a teacher overseeing everything, and students can discuss their problems with the teacher immediately. Thus, an "instructor" is also needed in *V.E.E.* to help the students. All the instructor has to do in an experiment are to guide students and to advise them if the operation is wrong. In previous research of intelligent agent with *V.E.E.*, every step students operate will be recorded in log files, so as to assist the teacher in comprehending students' difficulty in learning [11][13]. To enhance the

ability of assistant agent, an interactive mechanism in IVC is supported by an intelligent agent. Generally speaking, there are three kinds of interactions within *V.E.E.* as shown in Figure 2: [16]

1. Learners send commands to agents for asking help or other demands.
2. Agents send commands to *V.E.E.* suchlike advising messages or Experiment Action Language for doing experiment operated through learners.
3. Commands send from *V.E.E.* to agents including experiment status, experiment data, or even Experiment Action Language.
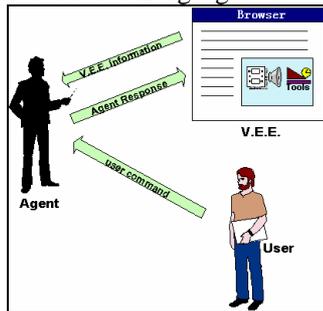

Figure 2: Interactions among *VEE*, agent and user

In such an architecture, it is hard to design a fitting intelligent agent because of the agent must have a lot of knowledge about the experiments in its "brain", and it should also have the ability of thinking to judge whether what students do is correct or not. Usually, a database is used to store general data; as regards the storage of knowledge, Knowledge Base is of great use. The way how agents gain knowledge for assisting and teaching students is to transform knowledge and then store it into Knowledge Base. When students need help, agent can put knowledge into Inference Engine at proper time and make the corresponding inference. [31]

The knowledge base used in IVC is called *Knowledge Map*. Based on the idea of concept map [24] and the schema, [9] two major parts consists in *Knowledge Map*: *Concept Hierarchy* and *Concept Schema*. [15] *Concept Hierarchy* presents the hierarchical relationship among concepts. *Concept Schema* stores the remaining information, which integrates the definition, example, and other relations with associated concepts. An example of *Knowledge Map* for partial domain of Physics is shown in (Figure 3). In Figure 3, *Concept Hierarchy* is demonstrated in gray block with link among concepts and *Concept Schema* of each concept is demonstrated in the white block.
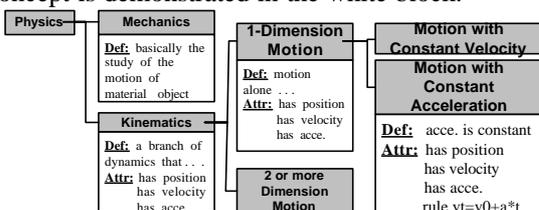

Figure 3: Knowledge Structure - Knowledge Map

The beginning usage of *Knowledge Map* is knowledge management. [32] To increase the ability of *Knowledge Map*, problem solving becomes the discussing issue. A problem is formed when someone has a goal and attempt to find a way to approach the target. [14] Hence some mechanisms of problem solving are developed. A proposal brought up by Marshall for problem solving includes four knowledge types of schema: identification knowledge, elaboration knowledge, planning knowledge, and execution knowledge. [22] Using these schemas, a problem solving system was constructed in recent work and its system architecture is shown in Figure 4. [6][15][29] A Problem Solving System loads a problem, which will be processed through four steps: problem identification, problem elaboration, problem planning, and problem execution. All these steps get knowledge from knowledge base in long-term memory and produce different schemas, like Problem Graph and Problem Matrix, stored in short-term memory.
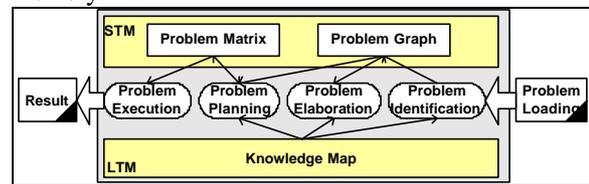

Figure 4: Problem Solving Steps

5. Data Mining with Knowledge Map

The further usage of *Knowledge Map* is data mining. One of the applications in data mining is misconception diagnosis. While students are studying, they might be confused with some ambiguous notions which are so called misconceptions. IVC provides an *On-Line Test System* for teachers to analyze students' misconceptions by examination. The first step of misconceptions diagnosis is question analysis. Questions are composed of three basic units: concepts, relationships, and propositions. [4][21][30] In an examination paper, every question is constituted by a group of propositions and answers, and propositions would be presented in a way of language. The concepts in the examination are organized in *Knowledge Map*. The concept structure will effect the calculation of embedded concept of the item in the examination.

Two major matrices are used for misconceptions diagnosis: *Embedded Concept Matrix* (*ECM*) and *Cumulative Embedded Concept Matrix* (*CEMC*). *ECM* is used to present the relationships among the items and concepts. However, one concept in the item may imply other related concepts. *CEMC* use *Knowledge Map* to calculate the hidden concepts. Figure 5 (b) displays three items related to the concepts which use *ECM* to present. After having *ECM*, Figure 6 calculates *CEMC* from *EMC*

according to the *Knowledge Map* in Figure 5 (a). Cooperating the answer of students', the diagnosis system can find the students' concept distribution matrix. In the diagnosis process, there is still a parameter required, *threshold*. This parameter characterizes student's misconceptions and falls between 1 and 0, with default value 0.5. That means if the value in student's concept distribution matrix is over the *threshold*, the related concept may be the misconception of student.
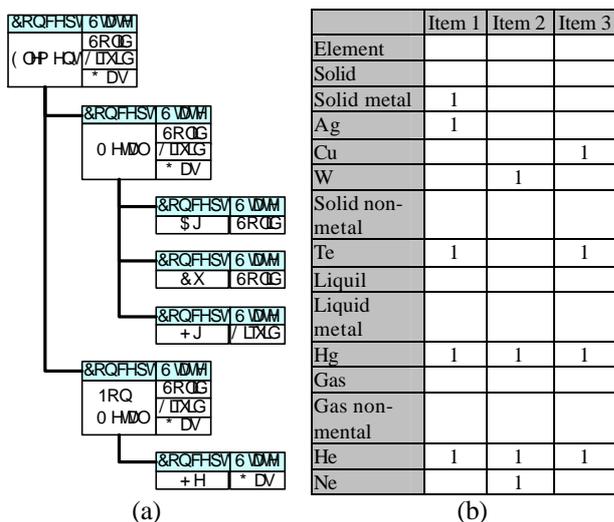
	Item 1	Item 2	Item 3
Element			
Solid			
Solid metal	1		
Ag	1		
Cu			1
W		1	
Solid non-metal			
Te	1		1
Liquil			
Liquid metal			
Hg	1	1	1
Gas			
Gas non-mental			
He	1	1	1
Ne		1	

(a) (b)

Figure 5: (a) Knowledge Map of example; (b) Embedded Concept Matrix (*ECM*) of example

	Item 1	Item 2	Item 3	Sum	CD
Element	4	4	4	12	1
Solid	2	1	2	5	5/12
Solid metal	1	1	1	3	3/12
Ag	1			1	1/12
Cu			1	1	1/12
W		1		1	1/12
Solid non-metal	1		1	2	2/12
Te	1		1	2	2/12
Liquil	1	1	1	3	3/12
Liquid metal	1	1	1	3	3/12
Hg	1	1	1	3	3/12
Gas	1	2	1	4	4/12
Gas non-mental	1	2	1	4	4/12
He	1	1	1	3	3/12
Ne		1		1	1/12

Figure 6: Cumulative Embedded Concept Matrix (*CEMC*) of example

Using the previous method of misconceptions measurement, IVC provides an *On-Line Test System* called *iTest System* as shown in Figure 7. Three major components are existed in the system: *Digital Item-Bank*, *On-Line Real-Time Test*, and *Real-Time Diagnosis*. Domain experts can use *Digital Item-Bank* to construct suitable items which analyzed based on *Knowledge Map*. After making a digital examination paper by domain experts, student takes exams in *On-Line Real-Time Test* on web. Both data from *Digital Item-Bank* and *On-Line Real-Time Test* will be sent to the last component, *Real-Time Diagnosis*, which use *EMC* and *CEMC* to estimate student's concept distribution. As a whole, students

could immediately know how they act at this test and the diagnosis just after finishing the examination in IVC. Also, the correct or wrong answers of all questions would be analyzed completely and displayed on a Web Page. Therefore, students can understand the meaning implied in the question entirely and realize what their misconceptions are through some advices provided by system for consultation [4].
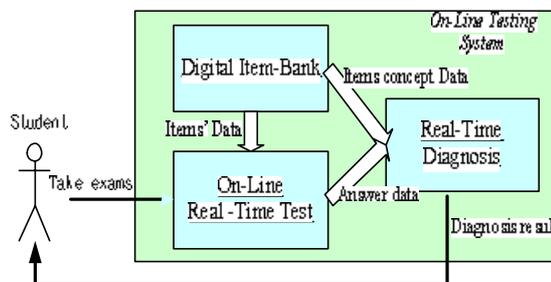
Figure 7: *iTest System* framework

6. Conclusion

This paper introduces many theorems and implementations about IVC system. Two major tools are supported in IVC: *Community Tools* and *Personal Tools*. Especially in *Learning Community*, Virtual Experiment Environment which includes two techniques: Visual Lab and Virtual Lab, is designed for providing a more integrated learning mechanism. Owing to the necessity for teachers being in a learning process, the idea of Intelligent Agent is proposed afterward. Three kinds of interaction between V. E. E. and Intelligent Agent are supported in IVC. To make an agent have ability to instruct and advise students, *Knowledge Map* is proposed as the knowledge structure in the intelligent agent. *Knowledge Map* is a hierarchical concept, which simulates the thinking mode of human brain.

This knowledge structure aids with four steps of problem solving, which comes from four knowledge schemas of Marshall. Another application of *Knowledge Map* is *On-Line Test System*. An *iTest System* is provided for teachers to examine students' learning states. The *iTest System* is separated into three components: *Digital Item-Bank*, *On-Line Real-Time Test*, and *Real-Time Diagnosis*. Two matrices help calculating the concept distribution of student's: *Embedded Concept Matrix* and *Cumulative Embedded Concept Matrix*. If students are confused with some misconceptions, an *iTest System* can help them find out what they mistake and correct it.

The future work of *Intelligent Agent* is automatically learning in *Knowledge Map*. [10] If a *Knowledge Map* can increase by reading structure documents, domain experts can spend just little time to construct *Knowledge Map* without understanding programming language. The ability of problem

solving can be also increased by GAs and GPs, which enhances the capability to process graph-form outcome. [5] Whether a problem is solvable or not is another thought-provoking issue for discussing. Moreover, analyze problem structure to retrieve problem difficulty can also be another interesting topic. [18][19] This analysis can help students understand the lack ability of problem solving when they have the wrong answer.

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